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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/816,503	04/01/2004	Hong-Jyh Li	2004P51130US/I331.128.101	8623

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EXAMINER	
JOHNSTON, PHILLIP A	

ART UNIT	PAPER NUMBER
2881	

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06/14/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/816,503	LI, HONG-JYH	
	Examiner	Art Unit	
	Phillip A. Johnston	2881	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *16 March 2007*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-31* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-31* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *01 April 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

Detailed Action

1. This Office Action is submitted in response to the amendment filed 3-16-2007, wherein claims 1-31 are pending.

Response to Arguments

2. Applicant's arguments filed 3-16-2007 have been fully considered but they are not persuasive.

3. Applicant argues at page 8 of the remarks that Collins and Jeon both fail to disclose an ion implantation system and that there is no motivation to combine Collins and Jeon.

4. The examiner disagrees. The claims of the instant application recite a plasma implantation system comprising; a vacuum chamber, a vacuum pump, a gas supply, a plasma generator, a voltage source and a sample holder, all of which the apparatus cited in the Collins reference provides. In addition, one of ordinary skill in the art would recognize that the plasma generator as taught in Collins is routinely used for plural plasma processing applications, including plasma assisted deposition, plasma immersion ion implantation, surface etching, stripping, and sputtering. See, for example USPN 5,965,034 to Vinogradov; USPN 6,127,275 to Flamm; and USPN 6,893,907 to Maydan.

In addition, practitioners in the implantation art would recognize that the Collins apparatus would be used for ion implantation applications without modification, by using the voltage source to apply a potential difference between the plasma and the

wafer, which attracts ions. See the abstract in USPN 6,893,907; and USPN 6,127,275 Col. 13, line 10-39.

Regarding the motivation to combine Collins and Jeon, the Jeon reference at Col. 14, line 9-20 states that, the source of nitrogen in the nitridation of high-k dielectric layers is provided by ion implantation, therefore one of ordinary skill would use the plasma source of Collins to provide ion implantation by applying the appropriate potential difference between the plasma and the wafer (see USPN 6,893,907).

5. The examiner has discovered several structural errors regarding the taking of official notice in the rejection mailed 8-09-2006 and is therefore withdrawn. A new office action is submitted below that more clearly defines the examiners position.

Claims Rejection – 35 U.S.C. 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

7. Claims 1,2,4-10,12,25,26,28 and 29 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 6,518,195 to Collins, in view of Jeon, U.S. Patent No. 6,790,755.

8. Regarding claims 1 and 8, Collins teaches plasma reactor 10 (Note Figure 1 below) having the following claimed elements;

(a) Vacuum chamber 11. Col. 7, line 8-11;

(b) Vacuum pump 21. Col. 7, line 28-33;

(c) Gas supplied through manifold G1. Col. 7, line 35-50;

(d) Plasma chamber 16A for coupling RF electromagnetic (em) energy into the source chamber 16A (plasma generator) to induce electric fields to ionize the process gas. Col. 8, line 39-53;

(e) Plural power supplies (voltage sources), where AC supply 31 provides RF for plasma generation to antenna 31 at the top of the chamber and at the bottom, power supply 42 provides a constant positive or negative DC bias between the sample holder and the chamber wall (Col. 11, line 60-67), where a negative bias extracts positive ions toward (accelerate) wafer 5, and repels negative ions; and

(f) Wafer support electrode 32C (sample holder). Col. 8, line 55-60;

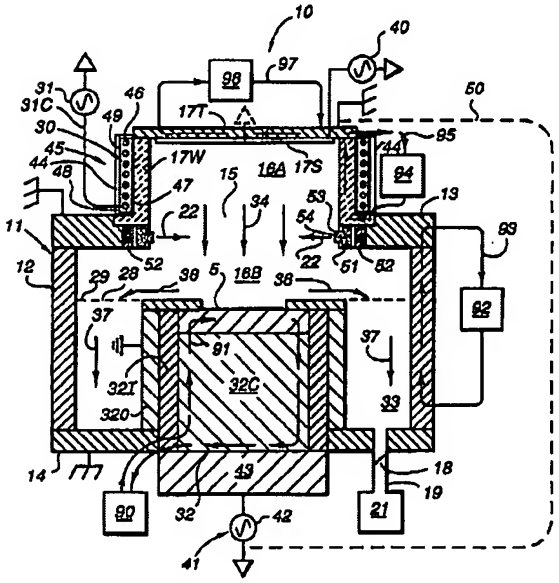

FIG. 1

9. Collins teaches all the required limitations of claims 1 and 8, as pointed out above.

10. Collins fails to disclose implanting ions into a high-k dielectric layer having a k value greater than 9.

11. Jeon teaches Nitrogen ion implantation after deposition of alternating sub-layers of high-k dielectric and areard-k dielectric materials on a semiconductor substrate. The high-K dielectric materials have a K value of about 20 or more. Such high-K dielectric materials include, for example, HfO_2, ZrO_2, and Ta2 O_5. Col. 4, line 1-10; Col. 14, line 9-20.

12. Jeon modifies Collins to provide nitridation of high-k dielectric layers to produce semiconductor devices having the electrical advantages of a higher K.

13. Therefore it would have been obvious to one of ordinary skill in the art that the plasma reactor apparatus of Collins can be modified to use ion implantation of high-k layers in accordance with Jeon, to provide a semiconductor device having a composite dielectric layer, where the composite dielectric layer is formed about the boundary of each first dielectric material layer/second dielectric material layer.

14. Regarding claims 2 and 10, the rational applied above to claims 1 and 8, also applies to claims 2 and 10, particularly the implantation of Nitrogen as taught in Jeon.

15. Regarding claims 4-7, the combination of Collins and Jeon teaches all the required limitations therein as described above regarding claims 1 and 8. Collins also teaches power supply 42 is also configured to supply AC voltages. Col. 8, line 55-60.

16. Regarding claim 9, the rational applied above to claims 1 and 8 also applies to claim 9. Note that voltage sources are connected to the holder and the chamber.

17. Regarding claim 12, the rational applied above to claims 1 and 8 also applies to claim 12. Particularly the use of HfO_2, ZrO_2, and Ta2 O_5, in accordance with Jeon.

18. Regarding claim 25, the combination of Collins and Jeon teaches all the structural elements therein as described above regarding claims 1 and 8. Collins also teaches evacuation of the interior of the chamber housing 11 (chamber 16) controlled by a throttle valve 18 in a vacuum line 19 connected to vacuum pumping system 21. Col. 7, line 28-33.

19. Regarding claim 26, the rational applied above to claim 25, and claims 2 and 10, also applies to the use of Nitrogen in a plasma recited in claim 26.

20. Claims 3,11,13-24, and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Collins and Jeon in view of USPN 2001/0054746 to Yamada.

21. Regarding claims 3,11,16, and 27, the combination of Collins and Jeon teaches all the required limitations therein as pointed out above regarding claims 1 and 8, but fails to teach implanting ions comprising one of F, Si, O, Hf, Zr, Ti, Ta, Y, V, Sc, Ba, Sr, Ru, B, Al, Ga, In, Ge, C, P, As, and Sb.

22. Yamada teaches ion-implanting Phosphoros (P) and Arsenic (As). See [0138].

23. Yamada modifies Collins and Jeon to provide ion-implantation of p-type impurities through an opening in the mask 200 to locally change an SOI silicon layer into the n-type collector region with a uniform concentration.

24. Therefore one of ordinary skill would select an ion to be implanted from the group above in order to provide doping levels for production of semiconductor devices with desired characteristics.

25. Regarding claims 13-15 the combination of Collins and Jeon teaches all the required limitations therein as described above regarding claims 1 and 8, but fails to teach the use of a buffer layer.

26. Yamada teaches a buffer layer 6 that is a semiconductor buffer layer such as amorphous silicon or epitaxially grown single crystal silicon, silicides, or metals, or insulating films of BSG (boron silicate glass), where the silicide or the metal particularly contributes to decreasing the resistance of the external base. See [0128] and [0141].

27. Yamada modifies Collins and Jeon to provide a method for making a silicide buffer layer, where a metal such as titanium (Ti) or cobalt (Co) stacked by sputtering, for example, is annealed by RTA (rapid thermal annealing) for a short time to make the metal and silicon react forming TiSi. [0161]

28. Therefore it would have been obvious to one of ordinary skill to provide plural buffer layers on silicide stacks that include metals such as titanium (Ti) or cobalt (Co), and implanting ions in the buffer layers to adjust doping levels.

29. Regarding claim 17, the rational applied above to claim 16 also applies to claim 17. The combination of Collins and Jeon teaches plasma processing of large semiconductor wafers, which inherently includes a pattern of adjacent devices, thus would also include the use of adjacent high-k dielectric layers.

30. Regarding claims 18 and 19, the combination of Collins and Jeon teaches all the limitations therein as pointed out above regarding claim 16.

31. Regarding claims 20-22, the rational applied above regarding claims 13-15, also applies to claims 20-22. In particular, the teaching of a buffer layer in Yamada.

32. Regarding claims 23 and 24, the rational applied above to claims 4-7, and 16, also applies to claims 23 and 24. Particularly, the teaching of plasma voltage sources in Collins.

33. Regarding claim 27, the rational applied above to claim 25, and claims 3 and 11, also applies to the recitation of the same group of elements in claim 27.

34. Regarding claims 28 and 29, the rational applied above to claims 4-7, and 25, also applies to the same recitation of voltage sources in claims 28 and 29.

35. Claims 30 and 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Collins and Jeon in view of USPN 6,248,662 to Wu.

36. Regarding claims 30 and 31, the rational applied above to claim 25 also applies to the structural elements of claim 30, but fails to teach the use of an implanting ions with an energy range of 5-10 kev and dosages greater than 1×10^{13} ions/cm^2 and less than 1×10^{16} ions/cm^2.

37. Wu teaches the use of an ion implantation sources where BF3 ions are implanted at a typical dosage of about $1.0E^{16}$/cm3 and a typical energy of about 5.0 KeV. Col. 3, line 5-17.

38. Wu modifies Collins and Jeon to provide an ion source where the energy of the implanted ions is restricted so that the implanted ions are only concentrated in the surface of the first dielectric layer, and the dosage of implanted ions is adjustable.

39. Therefore it would have been obvious to one of ordinary skill to implant ions at energies and dosages that have been selected to form void-free dielectric layers.

Conclusion

40. Any inquiry concerning this communication or earlier communications should be directed to Phillip Johnston whose telephone number is (571) 272-2475. The examiner can normally be reached on Monday-Friday from 7:30 am to 4:00 pm. If attempts to reach the examiner by telephone are unsuccessful, the examiners supervisor Robert Kim can be reached at (571) 272-2293. The fax phone number for the organization where the application or proceeding is assigned is 571 273 8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

PJ
May 31, 2007

Jack I. Berman
Primary Examiner